

**CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE  
FERTILIZER RESEARCH AND EDUCATION PROGRAM (FREP)**

**Final Report**

**A: Project Title** Western States Agricultural Laboratory      **Project Location:** Utah State University  
Sample Exchange Program (Continuation)

**Project Number:** 93-0568

**Project Leader(s)** (Name, Title, Affiliation, Mailing Address, Telephone #, Fax #)

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\* Original grant proposal 1993.

## **Western States Agricultural Laboratory Sample Exchange Program**

### **B. Objective(s)**

Continued development of the Western States Proficiency Testing program for the purpose of evaluating and improving the analytical performance of the commercial/public agricultural laboratory industry within California and the Western United States for soil and plant analysis. The long-term goal (1-2 years) will be to develop the program into the model for a national program serving all laboratories which routinely conduct agricultural analysis.

This would be accomplished by: (1) establishing standardized methods; (2) identifying those analytical method(s) which have problems with precision and or reproducibility; (3) developing long-term statistical information on the quality performance of the industry; and (4) providing technical assistance to those labs showing interest in improving the quality of their analytical operation. Results of the program at the end of each year would be made available to each of the participants of the exchange sample program and university extension personnel in the Western United States.

### **C. Executive Summary**

During the past four years, the Western States Agricultural Sample Exchange Program (known to program participants as the Western States Proficiency Testing Program) has provided a means for evaluating the proficiency of the agriculture laboratory industry in California and 30 states and provinces. The program involves the quarterly exchange of three soil and three plant samples among 108 laboratories on which standard soil and plant analysis is conducted using standard accepted methods referenced in a methods manual. The program has been well accepted by the California laboratories and ended 1997 with 42 labs located within plus 66 located outside the state. Results of the program have indicated that the laboratory industry is highly proficient at determining saturated paste moisture content, soil pH, soil electrical conductivity, nitrate, soil potassium, total soil Kjeldahl nitrogen, total nitrogen and total analysis for P, Ca, Mg, B, Zn and Mn in plant materials. Proficiency of soil phosphorus, extractable micro metals, plant nitrate and plant potassium is less than desirable with RSD values exceeding 40% on a majority of the soil and plant materials. For 1997 a web site and Laboratory Analysis Workshops were added to the program to provided better service and education to lab participants.



## **D. Work Discription**

### **Task 1: Collect samples and conduct 1996 program.**

Purpose to collect soil and plant samples and conduct 1996 proficiency testing program.

Estimated cost: \$ 42,755

Month of initiation: 1/96

CDFA Funding Portion: \$ 10,622

Month of Completion: 2/96

Other Funding: \$ 32,133

**Subtask 1.1:** Revise 1995 methods manual for 1996 with addition of soil pH 1:2, soil ammonium nitrogen and soil CEC. Make revisions to quarterly reporting format to include median average deviation for each analysis, and individual laboratory ranking. Complete by 1/15/96.

**Sub Task 1.2:** Complete travel to three locations spanning the Western United States to collect reference soil and plant reference materials. Soil materials representing 0-6 inch depth, air dried at 35 °C in an oven at 100 cfm air flow for 24 hours and pulverized to pass a 1.0 mm screen. Plant materials would be dried at 65 °C for 24 hours in an oven at 100 cfm air flow and dried material ground to pass an 0.2 mm screen. Purchase one NIST certified reference samples to be used in the program. Complete by 2/1/96.

**Subtask 1.3:** Collected soil material will be blended for 96 hours using a 10 ft<sup>3</sup> drum mixer. Homogeneity would be determined by subsampling and testing the sample variability for soil nitrate using excepted AOAC standard methods. Materials exhibiting an RSD of more than 5 % based on ten subsamples of the blend would be remixed. Plant materials will be blended in a 1.0 ft<sup>3</sup> drum for 96 hours. Homogeneity would be determined by subsampling and testing the sample variability for nitrogen by the method of Sweeny (1989, see citation) using a total nitrogen analyzer using the Association of Official Analytical Chemists (AOAC) method 975.03. Materials exhibiting an RSD of more than 3 % based on ten subsamples of the blend would be remixed. Soil and plant materials would be containerized in sealed bags of 350 g and 6 g respectively with appropriate coding information. Complete by 2/15/96.

**Subtask 1.4:** Initiate submission of first quarterly exchange sample set (three soils and three plant samples) beginning 2/15/96. Participating laboratories have 30 days to complete results and first quarterly report would be compiled for participants within 30 days thereafter.

**Subtask 1.5:** Submission of second quarterly exchange sample set (three soils and three plant samples) 5/15/96. Participating labs would have 30 days to complete results and second quarterly report would be compiled for participants 30 days thereafter. Submit mid year progress report to CDFA 6/15/96.

**Subtask 1.6:** Submission of third quarterly exchange sample set (three soils and three plant samples) 8/15/96. Participating labs would have 30 days to complete results and third quarterly report would be compiled for participants 30 days thereafter.

**Subtask 1.7:** Submission of fourth quarterly exchange sample set (three soils and three plant samples) 10/15/96. Participating labs would have 30 days to complete results and fourth quarterly report would be compiled for participants 30 days thereafter.

**Subtask 1.8:** Year-end summary report of first year. Data analysis on analytical precision for specified tests and temporal variation. Participants will be asked to evaluate the program. Submit progress report and invoices by 2/15/96.



## **E. Workplan and Methods (continuation)**

### **Task 2: Conduct Laboratory Exchange Program for 1997.**

Purpose to collect soil and plant samples and conduct 1997 proficiency testing program.

Estimated cost: \$ 40,613

Month of initiation: 1/97

CDFA Funding Portion: \$ 34,783

Month of Completion: 2/97

Other Funding: \$ 5,830

**Subtask 2.1:** Revise 1996 methods manual for 1997 with addition of soil pH 1:1 and soil/plant  $\text{SO}_4\text{-S}$ . Make revisions to quarterly reporting format to include median average deviation for each analysis, and individual laboratory ranking. Complete by 1/15/97.

**Sub Task 2.2:** Complete travel to three locations spanning the Western United States to collect reference soil and plant reference materials. Soil materials representing 0-6 inch depth, air dried at 35 °C in an oven at 100 cfm air flow for 24 hours and pulverized to pass a 1.0 mm screen. Plant materials would be dried at 65 °C for 24 hours in an oven at 100 cfm air flow and dried material ground to pass an 0.2 mm screen. Purchase one NIST reference samples to be used in the program. Complete by 2/1/97.

**Subtask 2.3:** Collected soil material will be blended for 96 hours using a 10 ft<sup>3</sup> drum mixer. Homogeneity would be determined by subsampling and testing the sample variability for soil nitrate using excepted AOAC standard methods. Materials exhibiting an RSD of more than 5 % based on ten subsamples of the blend would be remixed. Plant materials will be blended in a 1.0 ft<sup>3</sup> drum for 96 hours. Homogeneity would be determined by subsampling and testing the sample variability for nitrogen by the method of Sweeny (1989, see citation) using a total nitrogen analyzer using the Association of Official Analytical Chemists (AOAC) method 975.03. Materials exhibiting an RSD of more than 3 % based on ten subsamples of the blend would be remixed. Soil and plant materials would be containerized in sealed bags of 350 g and 6 g respectively with appropriate coding information. Complete by 2/15/97.

**Subtask 2.4:** Initiate submission of first quarterly exchange sample set (three soils and three plant samples) beginning 2/15/96. Participating laboratories have 30 days to complete results and first quarterly report would be compiled for participants within 30 days thereafter.

**Subtask 2.5:** Submission of second quarterly exchange sample set (three soils and three plant samples) 5/15/97. Participating labs would have 30 days to complete results and second quarterly report would be compiled for participants 30 days thereafter. Submit mid year progress report to CDFA 6/15/97.

**Subtask 2.6:** Submission of third quarterly exchange sample set (three soils and three plant samples) 8/15/97. Participating labs would have 30 days to complete results and third quarterly report would be compiled for participants 30 days thereafter.

**Subtask 2.7:** Submission of fourth quarterly exchange sample set (three soils and three plant samples) 10/15/97. Participating labs would have 30 days to complete results and fourth quarterly report would be compiled for participants 30 days thereafter.

**Subtask 2.8:** Year-end summary report of first year. Data analysis on analytical precision for specified tests and temporal variation. Participants will be asked to evaluate the program. Submit progress report and invoices by 2/15/97.



## E. Results Discussion and Conclusions

### 1996 and 1997 Programs

The following analyses were added to the 1997 Western States Agricultural Laboratory Proficiency Testing Program: soil particle size analysis (sand, silt and clay - hydrometer); soil buffer pH, Adams/Evans and Mehlich; Mehlich 3 extractable cations (K, Ca, Mg, Zn, Mn, Fe and Cu); and total plant sodium. The quantity of soil provided was increased to accommodate the increase in the number of analyses. The 1997 method's manual, was revised and provided to the participating laboratories (version 4.00). Laboratory workshops were added to the 1997 Western States Program list of activities.

The 1997 utilized robust statistics (median and median average deviation, MAD) as estimators of central values and variance for data sets from the Western States program. This replaced the use of the Dixon Massey test to generate a reduced data mean and standard deviation used in 1994 and 1995. Using this protocol Warning Limits were set at  $\pm 2.5 \times \text{MAD}$  and Control Limits at  $\pm 4 \times \text{MAD}$ . This statistical approach is less sensitive to the influence of extreme values (outliers). In specific instances this results in fewer reported values falling within warning and control limits than in previous exchanges.

The 1997 reporting sheet list: the analysis, number of reporting labs, minimum value reported, maximum value reported, median, MAD, and relative median average deviation (RMD %). To provide the participating laboratory with additional information we have included a column in the report listing the percentage of laboratory reporting values within established warning limits (median  $\pm 2.5 \times \text{MAD}$ ) of the median.

The Western States Program expanded in 1997 to include the coordination of proficiency check samples for the United States Golf Course Association (USGA) Green Section Proficiency Testing Program. This program involved the quarterly exchange of two golf green turf samples on which physical analyses are conducted. Analyses added for 1997 included: particle size analysis, hydraulic conductivity, porosity, organic matter content, particle and bulk density. Nine laboratories were enrolled in this program from across the United States, Canada and Great Britain.

### 1996 Quarterly Exchanges

For the 1st quarter exchange 90 of 96 enrolled laboratories provided results. Materials used in the 1st quarterly exchange, soil sample 96101 (**Fort Ellis**) was collected by Julie Armstrong, Director of the Montana State University, from a wheat field and is a Beaverton silt loam, taxonomic name: Loamy-skeletal, mixed Typic Argiboroll. Soil sample 96102 (**Greenville**) was collected by Janice Kotuby-Amacher, of Utah State University from a corn field and is a Millville silt loam, taxonomic name: Coarse-silty, carbonatic, mesic, Typic Haploxerolls. Soil sample 96103 (**Kansas**) was collected by David Whitney of Kansas State University was a Smolon silty clay loam, Taxonomic name: Fine, montmorillonitic, mesic, Pachic Agriustolls. Botanical sample 96201 is a **wheat / almond** (*Triticum / Prunus dulcis*) blended sample collected by Robert Miller, University California Davis. Plant sample 95202 is **lettuce** (*Lactuca sativa*) material collected by Bob McDole in Northern Idaho in 1985. Plant sample 95203 is a **tomato** (*Lycopersicon esculentum*) whole-plant composite collected by Robert Miller from the Sustainable Farming Systems Project located on the UC Davis Agronomy Farm.

The median values for these selected soils ranged from: pH (1:2) 5.63 - 8.38; SAR 0.25 - 12.0; soil bicarbonate extractable PO<sub>4</sub>-P, 6.4 - 34 mg kg<sup>-1</sup>; and DTPA extractable zinc 0.64 - 9.35 mg kg<sup>-1</sup>. Across all soil analyses an average of 82% of laboratory results were within established warning limits (median  $\pm 2.5 \times \text{MAD}$ ). Median values for the plant analyses ranged from: 1503 - 5441 mg kg<sup>-1</sup> NO<sub>3</sub>-N (ISE); 1.81- 5.11 % nitrogen; 0.210 - 0.605 % P (dry ash); 0.24 - 1.07 % S (microwave) ; 7.2 - 18.0 mg kg<sup>-1</sup> Cu. Across plant analyses an average of 85 % of laboratory results were within established warning limits.



For the 2<sup>nd</sup> quarter exchange 84 of 96 enrolled laboratories provided results. Materials used in the 2<sup>nd</sup> quarterly exchange, soil sample 96104 (**Sunland**) is a Cometa-Romona sandy loam, taxonomic name: Fine mixed thermic typic Palexeralfs - Fine loamy mixed thermic typic Hapoxeralfs collected from Placer County, CA by Gene Oliphant of Sunland Analytical Laboratory, Rancho Cordova, CA. Soil sample 96105 (**Tulare**) was collected by Tom Gerecke of California Farm Laboratories and is a panoche clay loam saline-alkali, taxonomic name: Fine-loamy mixed (Calcareous) thermic typic Torriorentent. Soil sample 96106 (**Kidman**) was collected by Janice Kotuby-Amacher, of Utah State University, is a Millville silt loam, taxonomic name: Coarse-silty carbonatic mesic Typic Haploxerolls. Botanical sample 96204 (**Tomato**, *Lycopersicon esculentum*) whole-plant composite collected by Robert Miller from the Sustainable Farming Systems Project located on the UC Davis Agronomy Farm, UC Davis, CA. Sample 95205 (**turf grass blend**) collected by Robert Miller UC Davis, CA. Sample 95206 (**Cotton**, *Gossypium*) blade sample collected by Nat Dellavalle of Dellavalle Laboratories, Fresno, CA.

The median values for these soils ranged from: pH (1:2) 6.58 - 8.00; SAR 0.29 - 7.5;; soil bicarbonate extractable PO<sub>4</sub>-P 16 - 31 mg kg<sup>-1</sup>; and DTPA extractable zinc 1.5 - 5.7 mg kg<sup>-1</sup>. Across all soil analyses an average of 81 % of laboratory results were within established warning limits. Median values for the plant analyses ranged from: 367 - 2365 mg kg<sup>-1</sup> NO<sub>3</sub>-N (ISE); 1.9 - 4.70 % nitrogen; 4.49 - 1.29 % K; and 0.27 - 1.61 % S. Across plant analyses an average of 87 % of laboratory results were within established warning limits.

For the 3<sup>rd</sup> quarter exchange 87 of 101 enrolled laboratories provided results. Materials used in the 3<sup>rd</sup> quarterly exchange, soil sample 96107 (**Carte**) was collected by Dr. Janice Kotuby-Amacher, Utah State University in Northern Utah and is a Millville silt loam, taxonomic name: Coarse-silty carbonatic mesic Typic Haploxerolls. Soil sample 96108 (**Dakota**) collected by Bruce Montgomery, Minnesota Dept of Agriculture. Soil sample 96109 (**Monona**) is a silt loam, Fine-silty, mixed, mesic Typic Hapludolls, collected in Sarpy County, by Dr. Robert Miller UC Davis, CA. Botanical sample 96207 (**Carnation**, *Dianthus caryophyllus*) straw was provided by Dr. Victor J.G. Houba, Department of Soil Science and Plant Nutrition, Wageningen Agricultural University. Sample 96208 (**Tomato**, *Lycopersicon esculentum*) whole-plant composite collected by Dr. Robert Miller from the Sustainable Farming Systems Project University California Davis, CA. Sample 96209 (**Peppermint**, *Mentha piperita*) whole plant stems was collected by Dr. Mel Wescott, Montana Western Ag Research Center.

For the 3<sup>rd</sup> Quarter soil samples median values for these soils ranged from: pH (1:2) 6.50 - 7.90; NO<sub>3</sub>-N, 5.0 - 38.7 mg kg<sup>-1</sup>; ammonium acetate K, 41 - 300 mg kg<sup>-1</sup>; DTPA extractable zinc, 0.74 - 2.0 mg kg<sup>-1</sup> and soil CEC, 13.0 - 20.0 cmol kg<sup>-1</sup>. Across all soil analyses an average of 83 % of laboratory results were within warning limits. Median values for the plant analyses ranged from: NO<sub>3</sub>-N (ISE), 1600 - 5370 mg kg<sup>-1</sup>; SO<sub>4</sub>-S, 1580 - 7900 mg kg<sup>-1</sup>; P, 0.281 - 0.680%; and Fe, 68 - 1240 mg kg<sup>-1</sup>. Across plant analyses an average of 87 % of laboratory results were within warning limits.

For the 4<sup>th</sup> quarter exchange 86 of 102 enrolled laboratories provided results. Materials used in the 4<sup>th</sup> quarterly exchange, soil sample 96110 (**Lucedale**) is a Lucedale sandy clay loam (taxonomic name: Fine-loamy, siliceous, thermic Rhodic Paleudults) collected by Dr. Charles Mitchell, Auburn University, Alabama. Soil sample 96111 (**Kohler**) is a Millville silt loam (taxonomic name: Coarse-silty, carbonatic, mesic Typic Haploxerolls) collected from a corn field by Dr. Janice Kotuby-Amacher, Utah State University. Soil sample 96112 (**Pittville**) is a sandy loam (taxonomic name: Fine-loamy, mixed, mesic Typic Argixerolls) collected by Dan Marcum, Farm Advisor Shasta County and Dr. Robert O. Miller, UC Davis. Sample 96210 (**Tomato**, *Lycopersicon esculentum*) whole-plant tomato composite collected by Dr. Robert Miller University California Davis. Botanical sample 96211 (**Cotton**, *Gossypium*) is a cotton petiole sample collected by Vicki Normandin of IAS Laboratories, Phoenix, AZ. Sample 96212 (**Swiss Chard**, *Beta Vulgaris* var. *cicla*) is a swiss chard petiole sample collected by Dr. Robert McDole, University of Idaho, Moscow, ID.

For the 4<sup>th</sup> Quarter soil samples median values for these soils ranged from: pH (1:2) 5.20 - 7.90; saturated paste boron, 0.08 - 0.20 mg L<sup>-1</sup>; NO<sub>3</sub>-N, 9.9 - 38.7 mg kg<sup>-1</sup>; ammonium acetate extractable K, 58 - 272 mg kg<sup>-1</sup>; DTPA extractable copper, 0.40 - 1.10 mg kg<sup>-1</sup> and soil CEC, 5.2 - 14.3 cmol kg<sup>-1</sup>. Across all soil analyses an average of 81 % of laboratory results were within warning limits (median  $\pm$  2.5 x MAD). Median values for the plant analyses ranged from: NO<sub>3</sub>-N, 1644 - 24126 mg kg<sup>-1</sup>; SO<sub>4</sub>-S, 754 - 9650 mg kg<sup>-1</sup>; and Fe, 84 - 1397 mg kg<sup>-1</sup>. Across plant analyses an average of 83 % of laboratory results were within warning limits.



## 1997 Quarterly Exchanges

For the 1st quarter exchange 90 of 102 enrolled laboratories provided results. Materials used in the 1st quarterly exchange 1997, soil sample 97101 (**Pajarito**) a Pajarito fine sandy loam (Coarse-loamy, mixed, superactive, thermic Typic Haplocambids) collected from a cotton field, LaPaz County, AZ, was supplied by Vicki Normandin, IAS Laboratory, Phoenix, AZ. Soil sample 97102 (**Ardek**) a Fort Collins Loam (fine, loamy, mixed, mesic, ustollic, Haplargid) collected from a wheat field on the Colorado State University Agricultural Research and Education Center by Dr. Robert Miller. Soil sample 97103 (**Lakeland**) a sand collected from a vegetable field by Dr. Arvel Hunter, Agro Services International, Orange City, FL. Botanical sample 97201 (**Pecan**, *Carya illinoensis*) was collected by Dr. J. Benton Storey of Texas A&M University, College Station, TX. Botanical sample 97202 (**Lettuce**, *Lactuca sativa*) a leaf sample collected by Robert McDole, retired, University of Idaho. Sample 97203 (**Rice**, *Oryza sativa*) was collected by Dr. Paul Bell of Louisiana State University, Baton Rouge, LA.

For the 1st Quarter soil samples median values for these soils ranged from: pH (1:2) 5.80 - 8.11; Soil ECe 0.28 - 7.7 dS m<sup>-1</sup>; NO<sub>3</sub>-N, 4.5 - 198 mg kg<sup>-1</sup> (cadmium reduction method); ammonium acetate extractable K, 10 - 470 mg kg<sup>-1</sup>; and soil CEC, 2.7 - 18.1 cmol kg<sup>-1</sup>. Across soil analyses an average of 82% of laboratory results were within warning limits. Median values for the plant analyses ranged from: NO<sub>3</sub>-N (ISE), 10 - 4400 mg kg<sup>-1</sup>; SO<sub>4</sub>-S, 32 - 1780 mg kg<sup>-1</sup>; B, 3.0 - 110 mg kg<sup>-1</sup>; and Cu, 4.0 - 13.4 mg kg<sup>-1</sup>. Across plant analyses an average of 78.8% of laboratory results were within warning limits.

For the 2nd Quarter 91 of 102 laboratories provided results. Materials used in the 2nd quarter 1997, soil sample 97104 (**Ardek**) a Fort Collins loam (fine, loamy, mixed, mesic, ustollic, Haplargid) was collected from wheat field on the Colorado State University Agricultural Research and Education Center by Dr. Robert Miller. Soil sample 97105 (**Idaho**) was a Palouse silt loam (fine, mixed, mesic, pachic, ultic, haploxerolls) from a wheat field in Latah County Idaho by Tom Case of the Analytical Sciences Laboratory, University of ID. Soil sample 97106 (Jerry Lu) was a **Jerryslu** loam (Fine-loamy, mixed, thermic Typic Natridurids) collected in Kern County California by Dr. Stuart Pettygrove of the University California Davis. Plant sample 97204 (**Wheat**, *triticum sativa*) was collected from a wheat field near Winters, CA. Botanical sample 97205 (**Potato**, *Solanum tuberosum*) was collected by Dr. Terry Tindall of the University of Idaho in Twin Falls, ID. Sample 97206 (**Pecan**, *Carya illinoensis*) whole-leaf composite was by Dr. J. Benton Storey Department of Horticulture Sciences, Texas A&M University, College Station, Texas.

Soil samples median values for the 2nd Quarter ranged from: pH (1:2) 6.17 - 8.10; Soil ECe 0.51 - 3.6 dS m<sup>-1</sup>; NO<sub>3</sub>-N, 9.1 - 27.9 mg kg<sup>-1</sup> (cadmium reduction method); ammonium acetate extractable soil Na, 52 - 811 mg kg<sup>-1</sup>; and DTPA extractable soil manganese, 5.8 - 29.8 mg kg<sup>-1</sup>. Across soil analyses an average of 81% of laboratory results were within warning limits (median  $\pm$  2.5 x MAD). Median values for the plant analyses ranged from: NO<sub>3</sub>-N (ISE), 65 - 3727 mg kg<sup>-1</sup>; SO<sub>4</sub>-S, 325 - 6983 mg kg<sup>-1</sup>; P (dry ash), 0.12 - 0.63 mg kg<sup>-1</sup> %; and B (microwave), 17.7 - 98.7 mg kg<sup>-1</sup>. Across plant analyses an average of 82% of the reporting laboratory results were within warning limits.

For the 3rd 89 of 104 laboratories provided results. Materials used in the 3rd quarterly exchange 1997, soil sample 97107 (Stratton) was a Norka loam (Fine-silty, mixed Aridic Argiustoll) collected from wheat field associated with the Agro-ecosystem Project in Kit Carson County CO, by Dr. Rodrigo Ortega of Colorado State University, Fort Collins, CO. Soil sample 97108 (Wellington) was a Fort Collins loam, (Fine, loamy, mixed, mesic, ustollic, Haplargid) collected from a wheat field on the Colorado State University Agricultural Research Development and Education Center (ARDEC) by Dr. Robert Miller. Soil sample 97109 (Brazos) was a Darco loamy fine sand (Loamy, siliceous, thermic, Grossarenic Paleudult) collected from bermuda grass (*Cynodon dactylon*) pasture by Dr. Vince Haby, Texas A&M University, College Station, TX. Plant sample 97207 (Hickory), was a pecan leaf composite (*Carya illinoensis*) collected in Western Texas in September 1996, by Dr. J. Benton Storey of Texas A&M University, College Station, Texas. Botanical sample 97208 (Swiss Chard, *Beta vulgaris* var. *cicla*) was a composite sample collected by Dr. Robert McDole, of the University of Idaho in 1990. Sample 97209 was a composite potato (*Potato*, *Solanum tuberosum*) sample collected by Dr. Terry Tindall of the University of Idaho in Twin Falls.



Soil samples median values for the 3rd Quarter ranged from: pH (1:2) 6.35 - 8.10; Soil E<sub>Ce</sub> 0.23 - 1.18 dS m<sup>-1</sup>; NO<sub>3</sub>-N, 2.5 - 27.7 mg kg<sup>-1</sup> (cadmium reduction method); ammonium acetate extractable soil K, 47 - 661 mg kg<sup>-1</sup>; DTPA extractable soil copper, 0.12 - 1.20 mg kg<sup>-1</sup> and soil clay content ranged from 4 - 35%. Across all soil analyses an average of 82% of the reporting laboratory results were within warning limits. Median values for the plant analyses ranged from: NO<sub>3</sub>-N (ISE), 160 - 13,600 mg kg<sup>-1</sup>; PO<sub>4</sub>-P, 324 - 1541 mg kg<sup>-1</sup>; K (Nitric/Perchloric digestion) ranged from 0.71 - 6.88%, P (dry ash), 0.11 - 0.25%; and B (microwave digestion), 19.0 - 98.3 mg kg<sup>-1</sup>. Across plant analyses an average of 83% of laboratory results were within warning limits (median  $\pm$  2.5 x MAD).

For the 4th quarter 93 of 108 laboratories provided results. Materials used in the 4th quarterly exchange 1997, soil sample 97110 (Columbia) was an Athena silt loam (Fine-silty, mixed, mesic Pachic Haploxerolls) collected by Brent Thyssen of Soiltest Farm Consultants Inc., Moses Lake WA. Soil sample 97111 (Gallo) is a Hilmar loamy sand (sandy over loamy, mixed, calcareous, thermic Aeric Halaquepts) collected by Melanie Bush of Gallo Vineyards Analysis Laboratory. Soil sample 97112 (Sherrod) is a Fort Collins loam, (fine, loamy, mixed, mesic, ustollic, Haplargid) collected from a wheat field on the Colorado State University Agricultural Research and Education Center (ARDEC) by Dr. Robert Miller. Plant sample 97210 (Barley) (*H. vulgare*), was collected by Dr. Robert O. Miller in Butte County, CA. Plant sample 97211 (Misc. Tree) is a composite pecan leaf composite (*Carya illinoensis*) collected by Dr. J. Benton Storey of Texas A&M University, College Station, TX. Sample 97212 (Aspen) is a composite Aspen Leaf (genus *Populus*) sample collected near Masonville, CO by Dr. Robert Miller.

Soil samples median values for the 4th Quarter ranged from: pH (1:1) 5.20 - 8.00; NO<sub>3</sub>-N, 7.3 - 27.5 mg kg<sup>-1</sup> (cadmium reduction method); ammonium acetate extractable soil K, 94 - 620 mg kg<sup>-1</sup>; and DTPA extractable soil manganese, 8.4 - 51.7 mg kg<sup>-1</sup>. Across soil analyses an average of 84% of the laboratory results were within warning limits (median  $\pm$  2.5 x MAD). Median values for the plant analyses ranged from: NO<sub>3</sub>-N (ISE), 129 - 7465 mg kg<sup>-1</sup>; PO<sub>4</sub>-P, 342 - 2270 mg kg<sup>-1</sup>; K (dry ash), 0.72 - 5.75 mg kg<sup>-1</sup> %; and B (microwave), 8.8 - 99.5 mg kg<sup>-1</sup>. Across plant analyses an average of 83% of laboratory results were within warning limits. A compost sample was included for the 3rd Quarter 1997. Fifty-five labs provided analytical results and a report is included with soil and plant data sheets. For specific analyses: saturated paste moisture, paste pH, nitrate, sulfur by dry combustion, and heavy metal analyses only a limited number of results were provided. Total Kjeldahl Nitrogen and N by combustion median values were comparable, 1.14% and 1.10% respectively. Variability for P, K, Ca, Mg, S and Na ranged from 9.5-12.7% based on the RMD. Boron results indicated a bimodal population of results with one peak with a median of 27 mg kg<sup>-1</sup> and the second of 37 mg kg<sup>-1</sup>. Sufficient laboratory interest was generated that a future compost laboratory proficiency program is under development for 1999.

An artificial soil saturated paste extract (solution sample 97401) was included in the 4th Qtr 1997 exchange. This sample was prepared from reagent chemicals at Colorado State University. Analyses included: pH, E<sub>Ce</sub>, Ca 2+, Mg 2+, Na+, SAR, HCO<sub>3</sub><sup>-</sup>, Cl<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, PO<sub>4</sub> 3<sup>-</sup>, SO<sub>4</sub> 2<sup>-</sup> and B. Results were provided by 64 laboratories. The computed median values closely approximated the prepared solution and those determined using standard addition by two participating laboratories. Exceptions were noted for E<sub>Ce</sub> and HCO<sub>3</sub> which were 10-20% lower for the computed median. Relative Median absolute Deviation (MAD/Median x 100) values were 12-19% for anions while those for cations were 5-7%. It was noted that the sum of the anions and sum of the cations were not equivalent for several labs.

### Lab Analysis Workshops

Three Laboratory Analysis Workshops have been held since January 1997: Salinas, California, Prosser, Washington and Denver, Colorado. Twenty-three individuals representing 18 laboratories attended the Salinas Workshop; 24 individuals representing 12 laboratories attended the Prosser Workshop; and 14 individuals attended the Denver Workshop (see Appendix B, brochure). Workshop topics included: soil pH measurements; laboratory quality control and problems solving; soil extractable phosphorus procedures; soil organic matter determination; soluble soil salts; use of ICP-AES in soil and plant analysis; comparison of plant digestion analytical methods, and managing laboratory workload. Invited workshop speakers Included: Byron Vaughan, Chief of lab services, Harris Laboratories; Lincoln, NE; Vicki Normandin, Laboratory Manager, IAS Laboratories, Dean Hanson, Lab



Director, Oregon State University; Phoenix, AZ; Don Horneck, Lab Director Agri-Check, Umatilla, OR; Gary Hergert, Soil Scientist University of Nebraska, North Platte, NE; Nat Dellavalle, Dellavalle Laboratories, Fresno, CA; Ray Tucker, Lab Director North Carolina Dept. of Agriculture; and Janice Kotuby-Amacher, Lab Director USU Analytical Laboratory, Logan, UT. Workshop evaluation forms indicated very positive responses on the topics covered. A fourth Laboratory Analysis Workshop is scheduled for October 18, 1998.

### **Western States Web Page**

A web page has been developed for the Western States Proficiency Testing Program. Information and results from the previous three years of the Western States Proficiency Testing Program and the newly developed United States Golf Association Proficiency Program can be accessed via the Internet at <http://rbt.agsci.usu.edu/soil.science/usual/aglab.pt/> or located via the Utah State University home page. Soil and plant materials utilized in the program can be reviewed on the web site and purchased as laboratory standards.

### **Future of the Western States Proficiency Testing Program**

A steering committee representing state and public soil/plant proficiency programs met in April, 1997 in Eagan Minnesota to discuss the potential of developing a single proficiency testing program for agronomic labs. Those in attendance represented State Programs in the Midwest conducting legislatively mandated proficiency programs, Commercial Labs, Agricultural Consultants, Regional Soil Fertility Workgroups (NEC-67, NCR-13, SERA-6 and WCC-103), Canadian Soil Science Society, American Society of Agronomy, US-EPA, Potash and Phosphate Institute, Soil and Plant Analysis Council, and the Western States Laboratory Proficiency Testing Program. From the meeting a new program was developed entitled North American Proficiency Testing Program (NAPT) and was initiated in January 1998. The 1998 NAPT Program is based on the former Western State Proficiency Testing Program and is operated by Utah State University. For 1998 the number of soils utilized in the program has been expanded from three to six per quarter. The 1998 program has 155 laboratories enrolled of which 28 are located in California.

In 1999 NAPT program will become a formal activity of the Soil Science Society of America, based in Madison Wisconsin. Operation of the program will continue to be coordinated by Dr. Janice Kotuby-Amacher of Utah State University and Dr. Robert O. Miller, Colorado State University.

### **F. Project Management and Evaluation**

The 1996 Western States Proficiency Testing Program had 102 laboratories enrolled at the end of the calendar year. The 1997 program had 108 laboratories enrolled. The 1998 NAPT Program has (current as of July 1, 1998) 155 laboratories enrolled.



## **G. Outreach Activities, January 1, 1996 - May, 1998**

### **Presentations**

January 17, 1996, Moses Lake, WA. Columbia Basin Soil Fertility Conference. Presentation: The Western States Proficiency Testing Program. 65 in Attendance.

March 14, 1996, Sandy, UT. Western Coordinating Committee on Nutrient Management. Presentation: Western States Proficiency Testing Program Future Directions. 20 in Attendance.

January 17, 1997, Visalia, CA. Presentation at the 1995 CA-ASA conference, entitled: Results of the 1996 Western States Proficiency Testing program. 80 in Attendance.

February 24, 1997, Salinas, CA. Presentation at the Laboratory Analysis Workshop entitled: Result of the 1996 Western States Proficiency Program. 24 in Attendance.

March 6-7, 1997, Salt Lake City, UT. Western Nutrient Management Conference, Poster: Result of the 1996 Western States Proficiency Program. 80 in Attendance.

March 25, 1997, Kearney Ag Center, Parlier, CA. Presentation at the UC Pomology Conference, entitled: Impact of Laboratory Quality on Agricultural Research. 40 in Attendance.

April 13, 1997, Eagan, MN. Presentation at North American Proficiency Testing Steering Committee entitled: Results of the Western States Proficiency Testing program. 35 in Attendance.

July 21, 1997, St. Paul, MN. Presentation to the Minnesota Soil Testing Laboratory's entitled: Results of the 1996 Western States Proficiency Program. 20 in Attendance.

August 4-8, 1997, Minneapolis, MN. Presentation at the International Symposium on Soil and Plant Testing entitled: 100 in Attendance.

September 15, 1997, Prosser, WA. Presentation at the Laboratory Analysis Workshop entitled: Result of the 1996 Western States Proficiency Program. 24 in Attendance.

September 21, 1997, Lincoln, NE. Presentation to the Nebraska Soil Testing Laboratory's entitled: Results of the 1996 Western States Proficiency Program. 15 in Attendance.

March 3, 1998, Denver, CO. Presentation at the Great Plain Soil Fertility Conference entitled: The impact of laboratory accuracy and precision on nutrient recommendation systems. 150 in Attendance.

March 4-5, 1998, Denver, CO. Presentation at the Laboratory Analysis Workshop entitled: Results of the 1996 Western States Proficiency Program. 14 in Attendance.

March 14-16, 1998, Honolulu, HI, Western Coordinating Committee on Nutrient Management. Presentation: Western States Proficiency Testing Program. 25 in Attendance.

April 3, 1998, Calgary, Alberta, Canada. Presentation at the WESTCO annual meeting entitled: The impact of laboratory accuracy and precision on nutrient recommendation systems. 30 in Attendance.



## **Outreach Publications**

Miller, R.O. and Janice Kotuby-Amacher. 1997. Western States Proficiency Testing Program. Proceedings of the Western Nutrient Management Conference. Salt Lake City, UT March 6-7, 1997.

Miller, Robert O., Bruce Montgomery and Janice Kotuby-Amacher. 1997. Evaluation of laboratory proficiency using single and double blind evaluations. 1997 International Soil and Plant Analysis Symposium. Minneapolis, MN. August 2-7, 1997.

Hanson, Dean, Janice Kotuby-Amacher and Robert O. Miller. 1997. Soil Analysis: Western States Proficiency Testing Program. Fresenius' Journal of Anal. Chem. Institut Fresenius Gruppe Taunusstein, Germany (In Press).

Miller, R.O. and Janice Kotuby-Amacher. 1998. The impact of laboratory accuracy and precision on nutrient recommendation systems. Proceedings of the Great Plains Soil Fertility Conference. Denver, CO March 3-4, 1998.